PCT

(51) International Patent Classification 6 : H04N 7/18, 9/47	A1	(11) International Publication Number: WO 97/40624
		(43) International Publication Date: 30 October 1997 (30.10.97)

(21) International Application Number: PCT/US97/06844

(22) International Filing Date: 17 April 1997 (17.04.97)

(30) Priority Data:
08/635,692   22 April 1996 (22.04.96)   US

(71) Applicant: SENSORMATIC ELECTRONICS CORPORA-
TION [US/US]; 951 Yamato Road, Boca Raton, FL 33431-
0700 (US).

(72) Inventor: ELY, Reuel, Andrew; 560 N.W. 66th Avenue,
Plantation, FL 33317 (US).

(74) Agent: TORRENTE, John, J.; Robin, Blecker, Daley &
Driscoll, 330 Madison Avenue, New York, NY 10017 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DISTRIBUTED VIDEO DATA STORAGE IN VIDEO SURVEILLANCE SYSTEM
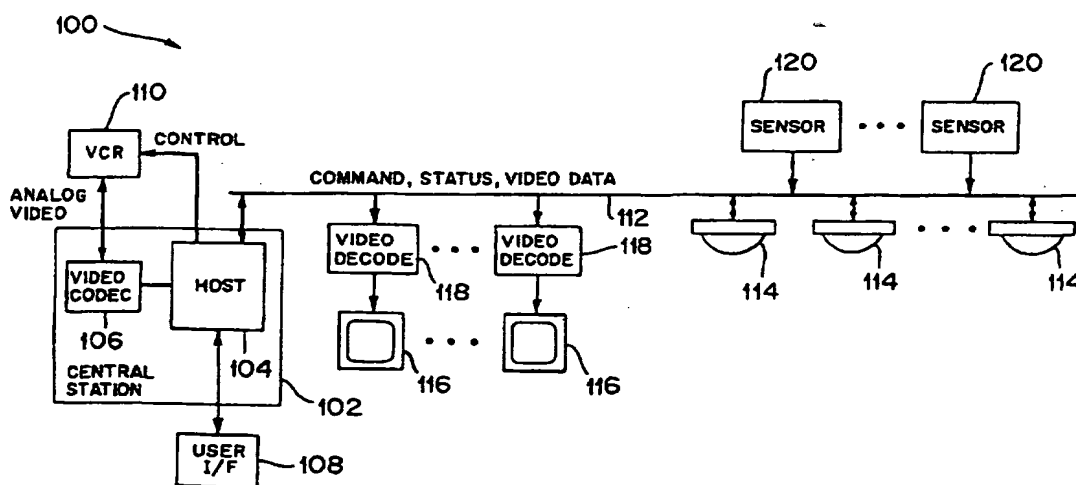
(57) Abstract

A video surveillance system includes a central control station (102) and a plurality of video cameras each mounted inside a dome housing unit (114). A video data buffer memory, storing compressed video data generated by the camera, is mounted with each camera in the respective dome unit. Data buffered at the dome units may be selectively protected from over-writing in response to alarm signals and then retrieved for display or tape-recording by the central control station. Both live and buffered video signals are transmitted in compressed form over the data network (112) that is also used for command, alarm and status messaging.

DISTRIBUTED VIDEO DATA STORAGE IN
VIDEO SURVEILLANCE SYSTEM

FIELD OF THE INVENTION

5

This invention is related to video surveillance systems, and more particularly to surveillance systems of the type which include sensors for advising the system of alarm conditions.

10

BACKGROUND OF THE INVENTION

A conventional closed-circuit video surveillance system, indicated generally by reference numeral 10, is illustrated in block diagram form in Fig. 1.

15 The surveillance system 10 includes a host computer 12, which controls the operation of the system, a video switch 14 which selectively interconnects input video signals (represented by dashed lines 16) with outputs of the switch (represented by dashed lines 18). Also included in the

20 system 10 are video cameras 20, monitors 22, control consoles 24, and sensor devices 26. A local area network 28 is provided for interchange of command, status and alarm data between the system host 12 and the cameras 20, control consoles 24 and sensors 26.

25 A user interface 30 is also provided to permit a system operator to control operations of the system. The interface 30 may incorporate a monitor and a control console which are not shown separately from the user interface 30. Also included in the system 10 are one or more video cassette

30 recorders 32 which are available to record video signals that are generated by the video cameras 20 and selectively routed to the VCRs 32 by way of the video switch 14. Video signals previously recorded by the VCRs 32 can be played back by the VCRs 32 and selectively routed through the

35 switch 14 for viewing on one or more of the monitors 22. As is well known to those who are skilled in the art, system host 12 also controls the video switch 14 so that, in response to control signals entered via the control consoles

24, video signals generated by a selected one of the video
cameras 20 is routed for viewing at a selected one of the
monitors 22. Sensors 26 generate alarm signals in response
to anomalous events such as unauthorized opening of doors,
5   windows or display cases. The system host 12 operates to
inform the human operator of the alarm conditions, and
predetermined camera movements and routing of corresponding
video signals to pre-selected monitors 22 may be
automatically actuated in response to alarm signals.
10 Movement of the cameras can also be controlled through
commands issued by the system host, in response to pre-
programmed surveillance routines, or in response to operator
input through the control consoles 24 or the user interface
30.

15   It is generally a desired goal in video surveillance
systems that video signals representative of conditions
before, during and after the onset of an alarm event be
recorded for current and future reference, subsequent legal
proceedings, and so forth, and it is for this purpose that
20 the VCRs 32 are provided. However, surveillance systems
frequently include a large number of video cameras (e.g.,
dozens or hundreds of cameras), and the cost of video
cassette recorders is too high to permit recording of the
signals generated by more than a few of the cameras at any
25 given time. In conventional systems, video signals
indicative of conditions prior to an alarm event cannot be
recorded, unless the output of a video camera has been
routed for recording by a VCR prior to the time an alarm
event occurs.

30   To maximize the recording capacity of the VCRs, it is
known to provide space-division-multiplexed (e.g., quad
multiplexed) signals for recording on VCRs 32, and it is
also known to operate the VCRs in a time lapse mode, with a
reduced frame rate and switching among a number of cameras.
35 When an alarm occurs, the time lapse mode can be
automatically stopped in favor of a standard frame rate
recording operation for the critical camera or cameras. In
addition, critical cameras can be connected at all times for

recording by a dedicated VCR. There are, however, disadvantages with all of these techniques. As noted above, it is quite expensive to provide a large number of VCRs, and if space-division-multiplexing is employed, the spatial
5 resolution of the image signal is reduced, which may impair recognition of critical elements of the recorded images. On the other hand, time lapse recording suffers from reduced temporal resolution, so that again critical events may be missed. And, as noted before, if a camera having a view of
10 an alarm event is not being recorded prior to the alarm event, the critical video information may simply fail to be captured.

An "intrusion monitoring system" disclosed in U.S. Patent Nos. 5,109,278 and 5,111,291 (assigned to
15 Commonwealth Edison) attempts to address some of these problems by providing an analog-to-digital converter and frame buffers at the output of a video multiplexer. Although the system disclosed in the Com Ed patents provides some capability for capturing and storing signals indicative
20 of conditions at or before the time that an alarm event occurs, the system does not seem to be adapted to operate with a large number of cameras, and the temporal resolution is poor, especially when the system includes more than a minimal number of cameras.
25

OBJECTS AND SUMMARY OF THE INVENTION

It is accordingly an object of the invention to provide a video surveillance system having an improved capability for storage of video signals.
30   It is another object of the invention to provide a video surveillance system in which buffer storage is provided for video signals generated by all of the cameras in the system, and it is a further object to provide such buffer storage for all cameras in the system even when the
35 number of cameras is large.

It is still a further object of the invention to provide a video surveillance system in which a human operator can conveniently control buffering and permanent

recording of video signals generated by all of the video
cameras in the system.

It is yet another object of the invention to provide a
video surveillance system in which storage for video signals
5   generated by each camera is carried out at low cost.

It is yet a further object of the invention to provide
a video surveillance system which requires less cabling than
conventional systems.

According to an aspect of the invention, there is
10 provided a video surveillance system, including a central
station, a plurality of video cameras located remotely from
the central station for generating respective video signals,
a plurality of storage devices, each located remotely from
the central station and associated with a respective one of
15 the video cameras for storing digital video data
representative of the video signal generated by the
respective video camera, and connection circuitry for
forming a signal path between the central station and each
of the storage devices.

20   Further in accordance with this aspect of the
invention, the connection circuitry may include a plurality
of control devices each operatively connected to a
respective one of the storage devices for controlling the
respective storage device to operate as a ring buffer in
25 which digital video data representative of video signals
currently generated by the respective video camera is
written over oldest digital video data stored in the
respective storage device. The surveillance system provided
according to this aspect of the invention may further
30 include a sensor device for generating an alarm signal
indicative of an alarm condition, and circuitry for
transmitting the alarm signal from the sensor device to the
central station. The central station may respond to
receiving the alarm signal by transmitting a storage signal
35 to at least one of the control devices, such control device
or devices responding to the storage signal by inhibiting
over-writing of the oldest digital video data in the
respective storage device or devices controlled by such

-4-

control device or devices. Alternatively, the sensor device
may be coupled to the connection circuitry for transmitting
the alarm signal directly to the control device or devices,
such device or devices responding to the alarm signal by
5   inhibiting over-writing of the oldest digital video data in
the respective storage device or devices controlled by such
control device or devices.

Still further in accordance with this aspect of the
invention, the central station may selectively transmit a
10 retrieve signal to a selected one of the control devices,
which responds to the retrieve signal by transmitting to the
central station digital video data read out from the storage
device controlled by the selected control device.

The system provided in accordance with this aspect of
15 the   invention   may   further   include   a   display   device
associated with the central station for displaying images
corresponding to the digital video data read out from the
storage device and transmitted to the central station, as
well as a video tape recorder controlled by the central
20 station for recording signals corresponding to the digital
video data read out from the storage device and transmitted
to the central station.

The connection circuitry may include a common data
transmission   channel   by   which   command   signals   are
25 transmitted from the central station to the video cameras
and digital video data read out from the storage devices is
transmitted to the central station. The digital video data
stored in the storage devices and transmitted by the data
transmission   channel   may   be   compressed   video   data.
30 Preferably each of the storage devices is a solid state
memory and each is disposed in a respective housing together
with the respective video camera.

According to another aspect of the invention, there is
provided a surveillance video camera unit, including a
35 housing which includes a light transmissive portion, a video
camera disposed within the housing for forming an image from
light which passes through the light transmissive portion of
the housing and for converting the image into a video

signal, and a storage device, disposed within the housing, for storing digital data representative of the video signal.

5   Further in accordance with the latter aspect of the invention, the video signal generated by the video camera may be an analog video signal, in which case the camera unit includes conversion circuitry disposed within the housing for converting the analog video signal into a digital video signal, and processing circuitry disposed within the housing
10   for applying a data compression algorithm to the digital video signal to form compressed video data, the compressed video data being stored in the storage device. The conversion circuitry and the processing circuitry may be integrated with the video camera so that the video camera
15   outputs the compressed video data to the storage device.
        Still further in accordance with this aspect of the invention, the camera unit may include a control circuit disposed within the housing for controlling the storage device to operate as a ring buffer in which digital data
20   representative of a video signal currently formed by the video camera is written over oldest digital data stored in the storage device. In response to receiving an event signal, the control circuit inhibits over-writing of the oldest digital data.
25   There may further be provided in the camera unit a plurality of motors disposed in the housing for changing pan, tilt and zoom conditions of the video camera, and the control circuit generates control signals for controlling the plurality of motors, the camera unit further including
30   circuitry for transmitting the control signals from the control circuit to the plurality of motors. Preferably the storage device is a solid state memory.
        According to still another aspect of the invention, there is provided a method of storing video signals,
35   including the steps of generating digital video signals using a plurality of video cameras, storing the digital video signals generated by each camera in a respective storage device provided adjacent to the camera, and

selectively transmitting to a central station the digital video signals stored in each storage device. Further in accordance with this aspect of the invention, the method may include operating the storage devices as ring buffers in

5   which currently generated digital video signals are written over oldest digital video signals stored in the storage devices, and inhibiting the over-writing of the oldest digital video signals in response to receipt of an event signal. The method may also include the steps of tape-

10 recording signals corresponding to the digital video signals transmitted to the central station, and displaying images corresponding to the digital video signals transmitted to the central station.

According to yet another aspect of the invention, there

15 is provided a video surveillance system including a plurality of video cameras for generating the video signals, digital storage circuitry for storing the video signals in the form of digital video data, control circuitry for generating camera control commands, data transmission

20 circuitry for forming a data communication channel by which the camera control commands are transmitted from the control circuitry to the plurality of video cameras, and circuitry for retrieving the stored digital data from the digital storage circuitry and for transmitting the retrieved digital

25 video data to the control circuitry via the data communication channel formed by the data transmission circuitry.

The video signals generated by the video cameras may be analog video signals, in which case the digital storage

30 circuitry includes circuitry for converting the analog video signals into digital video signals and circuitry for compressing the digital video signals to form compressed digital video data. Alternatively, the video signals generated by the video cameras may be in the form of

35 compressed digital video data.

The digital storage circuitry may include a plurality of digital storage devices, each located adjacent to a respective one of the video cameras, and the retrieving

circuitry may include a plurality of control devices, each associated with the respective one of the digital storage devices. Preferably, each of the storage devices is a solid state memory.

5   By providing a video surveillance system that includes camera units having digital storage for signals generated in the respective camera unit, video signals corresponding to conditions before, during and after an alarm event can be conveniently and reliably stored, and the locally stored
10 video can be read out and transmitted to an operator-attended station at a convenient time for viewing and permanent recording on video tape. The data communication network used for transmission of command and status data between the system central station and the video cameras may
15 be provided with sufficient capacity to handle transmission of compressed video data buffered or currently generated at the video camera units, in which case separate video signal transmission cabling can be dispensed with.

       The foregoing and other objects, features and
20 advantages of the invention will be further understood from the following detailed description of preferred embodiments and practices of the invention and from the drawings, wherein like reference numerals identify like components and parts throughout.
25

DESCRIPTION OF THE DRAWINGS

       Fig. 1 is a block diagram of a conventional video surveillance system.

       Fig. 2 is a block diagram of a video surveillance
30 system provided in accordance with the present invention.

       Fig. 3 is a schematic illustration of a video camera unit used in the system of Fig. 2.

       Fig. 4 is a flow chart of processes carried out in a control circuit that is part of the camera unit of Fig. 3.
35   Figs. 5A and 5B together form a flow chart of processes carried out in a host computer that is part of the system of Fig. 2.

DESCRIPTION OF PREFERRED EMBODIMENTS AND PRACTICES

An embodiment of the invention will now be described, initially with reference to Fig. 2. Reference numeral 100 generally indicates a video surveillance system provided in 5 accordance with the invention. The system 100 includes a central station 102 at which a host computer 104 is provided. Associated with the host computer 104 are a video data encoding/decoding device 106 and hardware and software required to provide a user interface, represented by block 10 108. The host computer 104 controls a video cassette recorder 110. A local area network (LAN) 112 is connected to the host computer 104. Data communicated between the host 104 and other components of the system 100 is carried over the LAN 112. Other system components connected to the 15 host computer 104 via the LAN 112 include camera units 114, monitors 116 (each connected to the LAN 112 through a respective video data decoding device 118) and sensor devices 120. The sensor devices 120 are preferably of conventional types that detect, for example, unauthorized 20 opening of doors, windows and display cases and the like and generate alarm signals indicative of these occurrences. The sensors 120 may also include conventional motion and/or heat sensing devices. The monitors 116 and the VCR 110 are also preferably conventional commercially-available items. It 25 should be understood that although only one VCR 110 is shown in Fig. 2, two or more VCRs may be provided as part of the system 100.

Although the user interface 108 is represented separately from the monitors 116, it should be understood 30 that the user interface preferably includes one or more of such monitors, as well as other input/output devices commonly provided as peripherals to personal computers. In addition, the user interface 108 may include one or more camera control devices such as the "TOUCHTRACKER" control 35 consoles marketed by the assignee of this application. Additional camera control consoles, although not shown, may be provided in the system at or remote from the central

station 102, and connected to the host 104 through the LAN
112.

The camera units 114 are preferably of a design
provided in accordance with an aspect of the invention, as
5   illustrated in Fig. 3.

Each camera unit may be mounted at a ceiling 122 or at
another appropriate location, and includes a housing 124
constituted, at least in part, by a base portion 126 and a
dome portion 128. In accordance with conventional practice,
10 the dome portion 128 is formed of a light-transmissive
material that allows light to enter the interior of the
housing 124, although the material of which dome 128 is made
be "one way" so that the interior of the unit 114 is
screened from view.

15   Mounted within the housing 124 of the camera unit 114,
and preferably mounted on the base portion 126, are a video
camera 130, motors and other structure 132 for changing pan,
tilt, zoom and/or other conditions of the camera 130, a
control circuit 134, and a memory board 136. The camera 130
20 may be of conventional design, and includes an optical
system 138 that receives and forms into an optical image
light 140 which passes through the dome 128 into the
interior of the camera unit 114. The image formed by the
optical system 138 is converted into an electrical signal at
25 CCD 142 and the resulting signal is subjected to
conventional analog signal processing at video signal
processing circuit 144. A suitable camera for use in the
camera unit 114 is commercially available from the assignee
of the present application, Sensormatic Electronics
30 Corporation, as part number 2003-0037-00. Other suitable
cameras are also commercially available.

The camera mounting structure, pan, tilt, and zoom
motors, and so forth indicated by reference numeral 132 are
also preferably of conventional design, such as are provided
35 on commercially available camera dome units. The control
circuit 134 may be a conventional microcontroller, such as
is currently used in camera dome units to receive command
signals from, and transmit status data to, a system central

control station, and also for controlling the camera motors
and detecting the status (such as position) of the camera
motors, in a conventional manner. However, the control
circuit 134 shown in Fig. 3 is also programmed, according to
5 practices of the present invention, to carry out memory
control, as well as data storage and retrieval functions
that will be described below.

The memory board 136 is provided in accordance with the
invention to receive an analog video signal output from the
10 camera 130 and to digitize, compress and store the video
signal. Components of the memory board 136 include a video
digitizer circuit 146, a video data coding/decoding circuit
148 and a memory device 150. The video digitizer 146 may be
suitably realized by the "WAVEWATCHER TV II" video digitizer
15 card available from AITech International, Fremont,
California. A suitable video codec is the model VCI-10,
available from VistaCom, OY, Tietajantie 14, 02130, Espoo,
Finland. The model VCI-10 compresses video data in
accordance with the H.261 standard, and also provides the
20 function of reconstituting video data that has been
compressed in accordance with that standard. The memory
device 150 may be constituted by one or more of RAM, EEPROM,
flash memory, and so forth. As will be seen, the memory
device 150 functions as a buffer for the video signal
25 generated by the camera 130, and is controlled by the
control circuit 134.

It is expected that, within a short time, there will
become commercially available video cameras which
incorporate the video signal digitizing and compression
30 functions carried out at blocks 146 and 148 in Fig. 3. For
example, commercial introduction of a video camera which
outputs compressed digital video data in accordance with the
above-mentioned H.261 standard is anticipated. Such a
camera could be used in place of the camera 130 shown in
35 Fig. 3, and the separately-provided video digitizer 146 and
video codec 148 could be omitted, with the compressed
digital video signal output from the camera being stored

directly in the memory device 150 under the control of the control circuit 134.

Operation of the camera unit 114 will now be described, with reference to Fig. 4, which illustrates processes

5   carried out by the control circuit 134 under the control of a stored program. (It will be understood that the program memory is not shown separately from the control circuit 134.)

One ongoing process carried out under normal conditions

10 by the control circuit 134 is transmission to the central station (via LAN 112) of compressed video data which represents video signals currently being generated by the camera 130. This process, represented by block 152, includes receiving the live compressed video data from the

15 video codec 148 and coupling the data onto the LAN 112, either according to predetermined time slots, or in response to commands from the central station, or according to some other protocol. In parallel with the process represented by block 152, the live compressed video data formed by the

20 video codec 148 is also stored in the memory 150. Preferably the memory addressing and writing of data into the memory is controlled by the control circuit 134 so that the memory 150 serves as a ring buffer, in which currently generated compressed video data is written over the oldest

25 compressed video data that had previously been stored in the memory 150. However, over-writing of the oldest data is subject to inhibition in response to alarm commands. On such occasions, the live compressed video data is written into a portion of the memory device 150 which does not hold

30 video data that is to be preserved.

In a third ongoing process, represented by block 156, the control circuit 134 handles camera control commands received via the LAN 112. The handling of camera control commands is in accordance with conventional practice, and a

35 further discussion thereof consequently will be omitted.

Concurrently with the ongoing processes of blocks 152, 154 and 156, the control circuit 134 is conditioned to receive occasional alarm commands, as indicated by decision

-12-

block 158. When an alarm command is received, a process
(indicated by block 160) is carried out in which the control
circuit 134 protects from over-writing compressed digital
video data previously stored in the memory 150, and
5   corresponding to a time interval beginning at a
predetermined time prior to receipt of the alarm command,
and continuing for a predetermined time after receipt of the
alarm command.

The control circuit 134 is also conditioned (as
10 indicated by decision block 162) to receive commands calling
for reading-out and transmission to the central station of
previously-stored compressed video data. The stored data to
be retrieved may be data that was previously protected from
over-writing in response to an alarm command, or may be
15 other data that has previously been stored in the buffer
memory 150. When a retrieve command is received, a process
for reading out the stored data from the buffer memory and
transmitting the read-out data via the LAN 112 is carried
out, as represented by block 164. The transmission of the
20 compressed video data that was read out from the memory 150
may be in place of, or virtually in parallel with, continued
transmission of "live" compressed video data. Preferably,
as suggested by Fig. 4, transmission of stored compressed
video data in response to corresponding retrieval commands
25 does not interrupt ongoing storage of "live" video data.

As indicated by decision block 166, the control circuit
134 is also conditioned to receive "clear" commands, in
response to which the control circuit removes a previously
protected block of stored video data from protection,
30 thereby permitting "live" video data to be written over the
now-unprotected stored video data.

Overall operation of the system 100 (Fig. 2) will now
be described, with reference to Figs. 5A and 5B, which
illustrate processes carried out by the host computer 104.
35 As indicated at block 170 in Fig. 5A, one ongoing
process performed by the host computer 104 entails
controlling camera movements, etc., in response to
instructions input by users of the system. The instructions

may be received either through the user interface 108, or via separate camera control consoles, which are not shown. The receipt of user instructions, processing of same by the host computer 104, generation of command data and

5   transmission of the command data via LAN 112, and camera movements (pan, tilt, zoom, etc.) in response to the commands are all preferably carried out in a conventional manner, and therefore will not be described further. The process 170 can also be considered as encompassing receipt

10   and processing of status data transmitted on the LAN 112 by the camera units 114, in accordance with conventional practice. Although the discussion up to this point has suggested that all user camera control instructions are processed in the host 104 and then relayed to the cameras

15   114 via the LAN 112, it is also contemplated that camera control consoles (not shown) connected to the LAN 112 may generate commands that are addressed directly to, and processed only by, camera units 114.

Another ongoing function carried out by the host

20   computer 104 is indicated at block 172 in Fig. 5A, and relates to handling user instructions for displaying "live" video signals generated by the cameras 114. In essence, the user instruction, as in conventional systems, specifies a particular camera unit, as well as a particular monitor on

25   which the signals generated by the camera unit are to be displayed. In conventional systems, such as the system illustrated in Fig. 1, display control instructions are implemented by controlling a video switch to make an appropriate connection between an input and an output of the

30   video switch. However, a salient characteristic of the system architecture shown in Fig. 2 is the omission of both the video switch and the analog video signal paths that are found in conventional systems. Instead, in the system of Fig. 2, video signals are transmitted over the LAN 112 in

35   the form of compressed digital video data. The "routing" of live video from a selected camera unit to a selected monitor is therefore carried out on a "virtual" basis. This may be done in a number of ways. For example, live compressed

-14-

video may be received by the host 104 from the camera unit (by way of LAN 112) and then retransmitted by the host 104 to the selected monitor 116, again via the LAN 112. Alternatively, the control circuit 134 of the selected

5   camera unit 114 can be instructed to address live video data directly to the selected monitor 116. The latter technique may be advantageous in that, when live video is not required from a given camera unit, the camera unit can be instructed not to transmit live video data (or instructions to transmit

10 can be omitted) thereby removing traffic from the LAN 112. In either of these cases, it will be understood that the video signal intended for a specified monitor 116 is received in compressed digital form at the video decoder 118 associated with the monitor 116 and is decompressed and

15 otherwise suitably processed at the decoder 118 to provide a signal which can be displayed on the monitor 116. According to another possible method of "routing" live video, the video decoders 118 may be conditioned to receive commands from the host 104, in response to which a video

20 decoder associated with a selected monitor 116 decodes and processes all video data transmitted on the LAN 112 by the camera unit 114 selected for display on the respective monitor 116. In other words, the virtual routing connection is made via an instruction to the receiving device (the

25 video decoder 118) rather than via an instruction to the sending device (the camera unit 114/control circuit 134).

Whether these techniques, a combination thereof, or other techniques are utilized, it will be appreciated that the LAN 112 should be selected so as to provide sufficient

30 bandwidth to accommodate not only conventional command, status and alarm signaling, but also the transmission of live video data as required. In addition, the LAN 112 must also handle transmission of video data that has been buffered at the camera units 114, as will be described in

35 more detail below.

It should be understood that conventional split-screen techniques, including use of video multiplexers such as conventional quad multiplexers, are also contemplated for

incorporation in the system of Fig. 2, although hardware for performing these functions is not explicitly shown in the drawing.

　　　　Another ongoing function of the host computer 104,
5　represented by block 174 in Fig. 5A, involves handling user instructions concerning operation of the VCR 110. The user instructions may include recording on videotape of either live or buffered video data received via the LAN 112, or playback of previously tape-recorded video signals. When
10　compressed video data received via the LAN 112 by the host 104 is to be recorded, the received video data is supplied from the host 104 to the video coder/decoder 106 for decompression and conversion into an analog video signal which is supplied to the VCR 110. Concurrently, the host
15　computer 104 provides a control signal that places the VCR in a mode for recording the analog video signal output from the video codec 106. When the user instruction indicates that playback of tape-recorded video is to be performed, the host 104 places the VCR 110 in a playback mode, and the
20　analog video output from the VCR 110 is subjected to appropriate processing within the central station 102 and then routed for display on a selected monitor, which may be part of the user interface 108.

　　　　The system architecture shown in Fig. 2 assumes that
25　conventional analog video tape recording is to be performed at VCR 110. However, an alternative contemplated by the invention provides for use of a digital video tape recorder (DVTR), in which case the video codec 106 processes the compressed video data supplied from the host 104 in an
30　appropriate manner so as to output a digital video signal that is suitable for recording on the DVTR.

　　　　It is also contemplated to permanently record compressed video data in the same form as transmitted over LAN 112. For example, a suitable data recorder could be
35　connected to LAN 112 to record compressed video data directly therefrom under control of the host 104. A data recorder could also be operated continuously to record all traffic on the LAN, including both live and buffered video

data. Such a recorder may use linear or helical-scan tape
recording, or may operate with a non-tape recording medium.

        As indicated at blocks 176 and 178 of Fig. 5A, the host
computer 104 is also responsive to alarm conditions, as may
5   be indicated by signals generated from the sensor devices
120. When a signal indicative of an alarm condition is
transmitted by a sensor 120 via the LAN 112 to the host
computer 104, the host responds by sending an alarm command
to certain predetermined camera units 114. For example, if
10 the sensor 120 is associated with a given door, and
indicates unauthorized opening of the door, the alarm
command is sent to a camera unit or units that have the door
within their field of view. As was discussed above in
connection with blocks 158 and 160 of Fig. 4, the
15 corresponding camera unit or units respond to the alarm
command by protecting buffered video data which corresponds
to a predetermined pre- and post-alarm time period. The
protected data is then available for subsequent retrieval,
display, and permanent recording via the VCR 110. After the
20 compressed video data stored at one of the camera units has
been protected pursuant to an alarm command, the data (which
will sometimes be referred to as "alarm data") can be
selectively retrieved in response to user instruction either
for display (block 180) or directly for tape-recording
25 (block 182).

        If a user indicates that a block of alarm video data is
to be displayed, the host 104 sends a retrieve command (via
LAN 112) to the selected camera unit 114 (block 184, Fig.
5B). The desired alarm data is then read out from the
30 buffer memory in the designated camera unit and transmitted
via the LAN 112, as was discussed above in connection with
blocks 162 and 164 (Fig. 4). The transmitted data is then
"virtually routed" to a designated monitor (block 186), by,
for example, any of the practices that were previously
35 described in connection with routing of live video. The
selected monitor may be a portion of the user interface 108,
in which case the routing may be by way of the host 104.
After the alarm data has been retrieved, the user has the

option, indicated at block 188, of recording the retrieved
alarm data. If this option is exercised, the alarm data,
having been re-buffered at the host computer 104, can be
cleared from the camera unit buffer by sending a clear
5   command (block 190, Fig. 5B) which causes the camera unit to
unprotect the data, as previously discussed in connection
with block 168 (Fig. 4). The retrieved alarm data is then
processed at the codec 106 and output as an analog video
signal for recording by the VCR 110 (block 192). Of course,
10 the host 104 concurrently provides a command signal to the
VCR to place it in a recording mode. As noted before, the
user may opt to record alarm data buffered at a camera unit.
If the user so elects (block 182), then the host 104 sends
a retrieve command to the selected camera unit (block 194,
15 Fig. 5B). After retrieval of the alarm data is complete, a
clear command is sent (block 196) to the camera unit to
clear the retrieved alarm data from the camera unit buffer,
and the retrieved alarm data is recorded on the VCR (block
198).

20   The processes illustrated in Figs. 5A and 5B call for
un-protecting of alarm data buffered in camera units once
the data has been retrieved by the central station for tape-
recording. However, other or additional camera buffer
management practices are also contemplated. For example,
25 assume that each camera unit buffer has a storage capacity
which corresponds to thirty minutes of video signals, and
that each alarm command initiates protection of buffered
video signals corresponding to a ten minute period (say five
minutes prior to the alarm and five minutes after). Each
30 camera unit can be arranged so that, after a third block of
alarm data has been protected and not cleared, then the
succeeding live data is written over the oldest of the three
blocks of alarm data. As another alternative, the camera
unit could send a message to the central station when a
35 predetermined proportion of the camera unit's buffer memory
has been utilized for protected storage, and then the
central station would operate to direct retrieval of the

-18-

alarm data from the buffers and clearing from the buffer of
the retrieved data.

It is also contemplated that downloading of the alarm
data from the camera units to the central station could be
5 performed in background, as time becomes available on the
LAN 112, rather than on a priority basis in response to
commands issued by the central station.

It should be understood that retrieval of buffer data
which has not been protected is also contemplated.

10 As an alternative to the "all-digital" architecture
shown in Fig. 2, in which the LAN 112 provides the only link
among the central station 102, the monitors 116 and the
camera units 114, it is also contemplated in accordance with
the invention to provide an architecture like that of Fig.
15 1, but utilizing camera units having local buffering
capabilities like those of the unit illustrated in Fig. 3.
In such an embodiment, both live and buffered video are
output from the camera unit in the form of conventional
analog video signals and are transmitted via appropriate
20 signal lines to a video switch provided at the central
station. The system host controls the video switch for
routing in accordance with conventional practice, and the
signals output from the video switch are transmitted via
appropriate lines to the monitors and the VCRs. Such an
25 embodiment would remove the burden of video data
transmission from the LAN used for command, status and alarm
messages, while still providing a capability for local
buffering of video signals at the camera units, with
selected retrieval of the buffered video at the command of
30 the central system or according to predetermined procedures.
However, if sufficient bandwidth is available on the LAN,
the all-digital architecture of Fig. 2 is preferred, since
neither the video switch nor the separate analog video
transmission lines would be required.

35 Alarms or other events that trigger protection of
buffered video data may be initiated by techniques in
addition to those discussed above. For example, in addition
to or in place of sensor-generated alarms, an alarm

-19-

condition can be generated by a system operator via the user interface, or an alarm condition can be detected by machine analysis of the content of live video signals generated by one or more of the camera units.

5   Various other changes in the foregoing apparatus and modifications in the described practices may be introduced without departing from the invention. The particularly preferred methods and apparatus are thus intended in an illustrative and not limiting sense. The true spirit and
10 scope of the invention is set forth in the following claims.

What is claimed is:

    1.   A video surveillance system, comprising:

    a central station;

    a plurality of video cameras, located remotely
5 from said central station, for generating respective video
signals;

    a plurality of storage means, each located
remotely from said central station and associated with a
respective one of the video cameras for storing digital
10 video data representative of the video signal generated by
the respective video camera; and

    connection means for forming a signal path between
said central station and each of said storage means.

    2.   A video surveillance system according to claim 1,
15 wherein said connection means includes a plurality of
control means each operatively connected to a respective one
of said storage means for controlling the respective storage
means to operate as a ring buffer in which digital video
data representative of video signals currently generated by
20 the respective video camera is written over oldest digital
video data stored in the respective storage means.

    3.   A video surveillance system according to claim 2,
further comprising:

    sensor means for generating an alarm signal
25 indicative of an alarm condition; and

    means for transmitting said alarm signal from said
sensor means to said central station.

    4.   A video surveillance system according to claim 3,
wherein said central station responds to receiving said
30 alarm signal by transmitting a storage signal to at least
one of said control means, said at least one of said control
means responding to said storage signal by inhibiting
overwriting of said oldest digital video data in the
respective storage means controlled by said control means.

35   5.   A video surveillance system according to claim 3,
wherein said sensor means is coupled to said connection
means for transmitting said alarm signal directly to at
least one of said control means, said at least one of said

control means responding to said alarm signal by inhibiting
overwriting of said oldest digital video data in the
respective storage means controlled by said control means.

      6.   A video surveillance system according to claim 2,
5 wherein said central station selectively transmits a
retrieve signal to a selected one of said control means,
said selected control means responding to said retrieve
signal by transmitting to said central station digital video
data read out from the storage means controlled by said
10 selected control means.

      7.   A video surveillance system according to claim 6,
further comprising display means associated with the central
station for displaying images corresponding to the digital
video data read out from the storage means and transmitted
15 to the central station.

      8.   A video surveillance system according to claim 7,
further comprising a video tape recorder controlled by said
central station for recording signals corresponding to the
digital video data read out from the storage means and
20 transmitted to the central station.

      9.   A video surveillance system according to claim 1,
wherein said connection means includes a common data
transmission channel by which command signals are
transmitted from said central station to said video cameras
25 and digital video data read out from said storage means is
transmitted to said central station.

      10.   A video surveillance system according to claim 2,
wherein said digital video data stored in said storage means
and transmitted by said data transmission channel is
30 compressed digital video data.

      11.   A video surveillance system according to claim 1,
wherein each of said storage means is a solid state memory.

      12.   A video surveillance system according to claim 1,
wherein each of said storage means is disposed in a
35 respective housing together with the respective video
camera.

      13.   A surveillance video camera unit, comprising:
        a housing including a light transmissive portion;

a video camera, disposed within said housing, for forming an image from light which passes through said light transmissive portion of said housing and for converting said image into a video signal; and

5   storage means, disposed within said housing, for storing digital data representative of said video signal.

14. A surveillance video camera unit according to claim 13, wherein said video signal is an analog video signal, and further comprising:

10   conversion means, disposed within said housing, for converting said analog video signal into a digital video signal; and

processing means, disposed within said housing, for applying a data compression algorithm to said digital

15 video signal to form compressed video data;

said compressed video data being stored in said storage means.

15. A surveillance video camera unit according to claim 14, wherein said conversion means and said processing

20 means are integrated with said video camera so that said video camera outputs said compressed video data to said storage means.

16. A surveillance video camera unit according to claim 13, further comprising control means, disposed within

25 said housing, for controlling said storage means to operate as a ring buffer in which digital data representative of a video signal currently formed by said video camera is written over oldest digital data stored in said storage means.

30   17. A surveillance video camera unit according to claim 16, wherein said control means, in response to receiving an event signal, inhibits said overwriting of said oldest digital data.

18. A surveillance video camera unit according to

35 claim 17, further comprising a plurality of motors disposed in said housing for changing pan, tilt and zoom conditions of said video camera, said control means generating control signals for controlling said plurality of motors, said

camera unit further comprising means for transmitting said
control signals from said control means to said plurality of
motors.

    19. A surveillance video camera unit according to
5 claim 13, wherein said storage means is a solid state
memory.

    20. A method of storing video signals, comprising the
steps of:

    generating digital video signals using a plurality
10 of video cameras;

    storing the digital video signals generated by
each camera in a respective storage device provided adjacent
to the camera; and

    selectively transmitting to a central station the
15 digital video signals stored in each storage device.

    21. A method according to claim 20, further comprising
the steps of:

    operating said storage devices as ring buffers in
which currently generated digital video signals are written
20 over oldest digital video signals stored in said storage
devices; and

    inhibiting said overwriting of said oldest digital
video signals in response to receipt of an event signal.

    22. A method according to claim 20, further comprising
25 the step of tape-recording signals corresponding to said
digital video signals transmitted to the central station.

    23. A method according to claim 20, further comprising
the step of displaying images corresponding to said digital
video signals transmitted to the central station.

30   24. A video surveillance system, comprising:

    a plurality of video cameras for generating video
signals;

    digital storage means for storing said video
signals in the form of digital video data;

35   control means for generating camera control
commands;

    data transmission means for forming a data
communication channel by which said camera control commands

are transmitted from said control means to said plurality of video cameras; and

     means for retrieving said stored digital video data from said digital storage means and for transmitting
5 the retrieved digital video data to said control means via said data communication channel formed by said data transmission means.

     25. A video surveillance system according to claim 24, wherein said video signals generated by said video cameras
10 are analog video signals, said digital storage means including means for converting said analog video signals into digital video signals and means for compressing said digital video signals to form compressed digital video data.

     26. A video surveillance system according to claim 24,
15 wherein said video signals generated by said video cameras are in the form of compressed digital video data.

     27. A video surveillance system according to claim 24, wherein said digital storage means includes a plurality of digital storage devices, each located adjacent to a
20 respective one of said video cameras.

     28. A video surveillance system according to claim 27, wherein said means for retrieving includes a plurality of control devices, each associated with a respective one of said digital storage devices.

25   29. A video surveillance system according to claim 28, wherein each of the storage devices is a solid state memory.
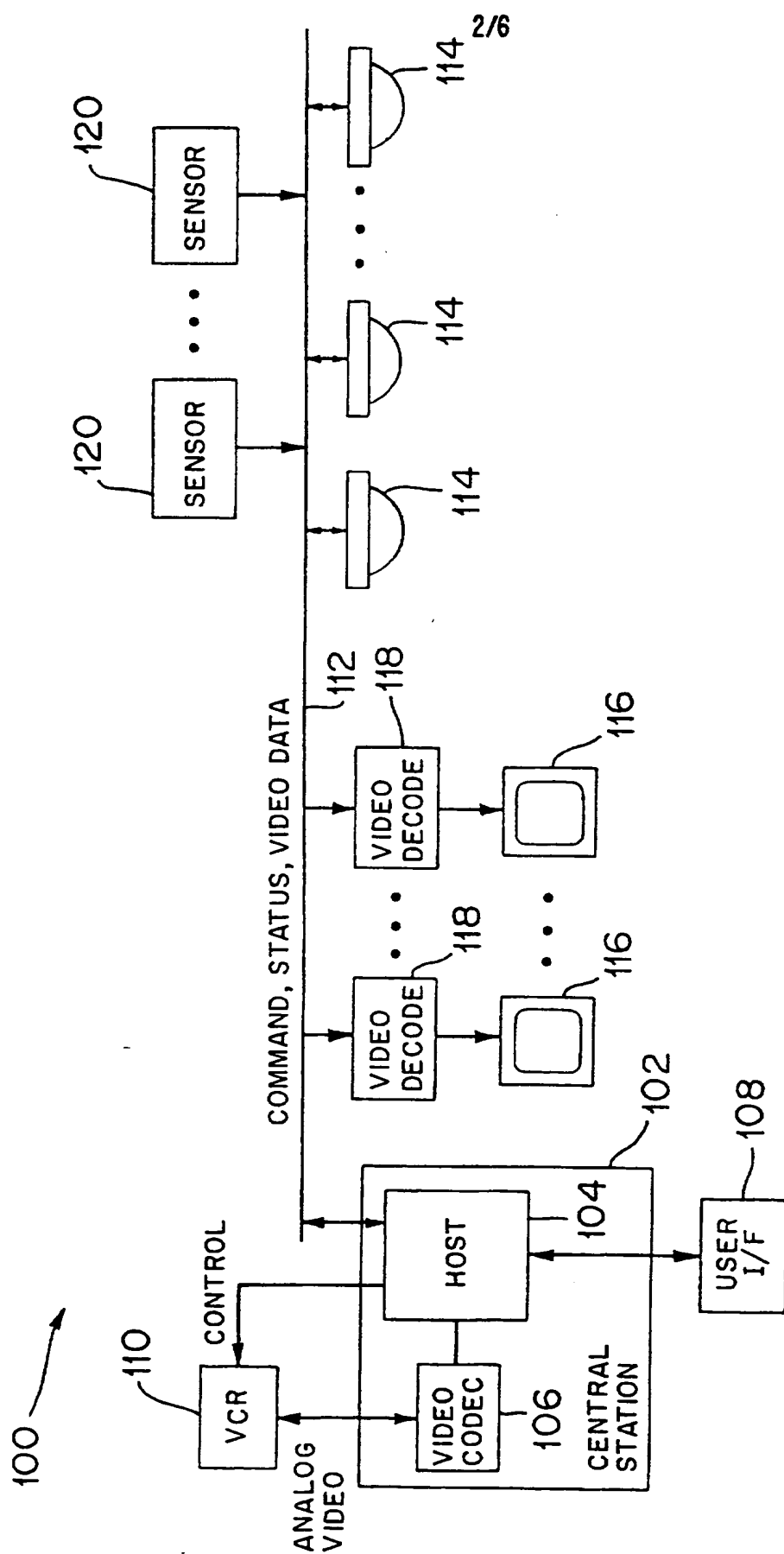
FIG. 1
(PRIOR ART)

2/6

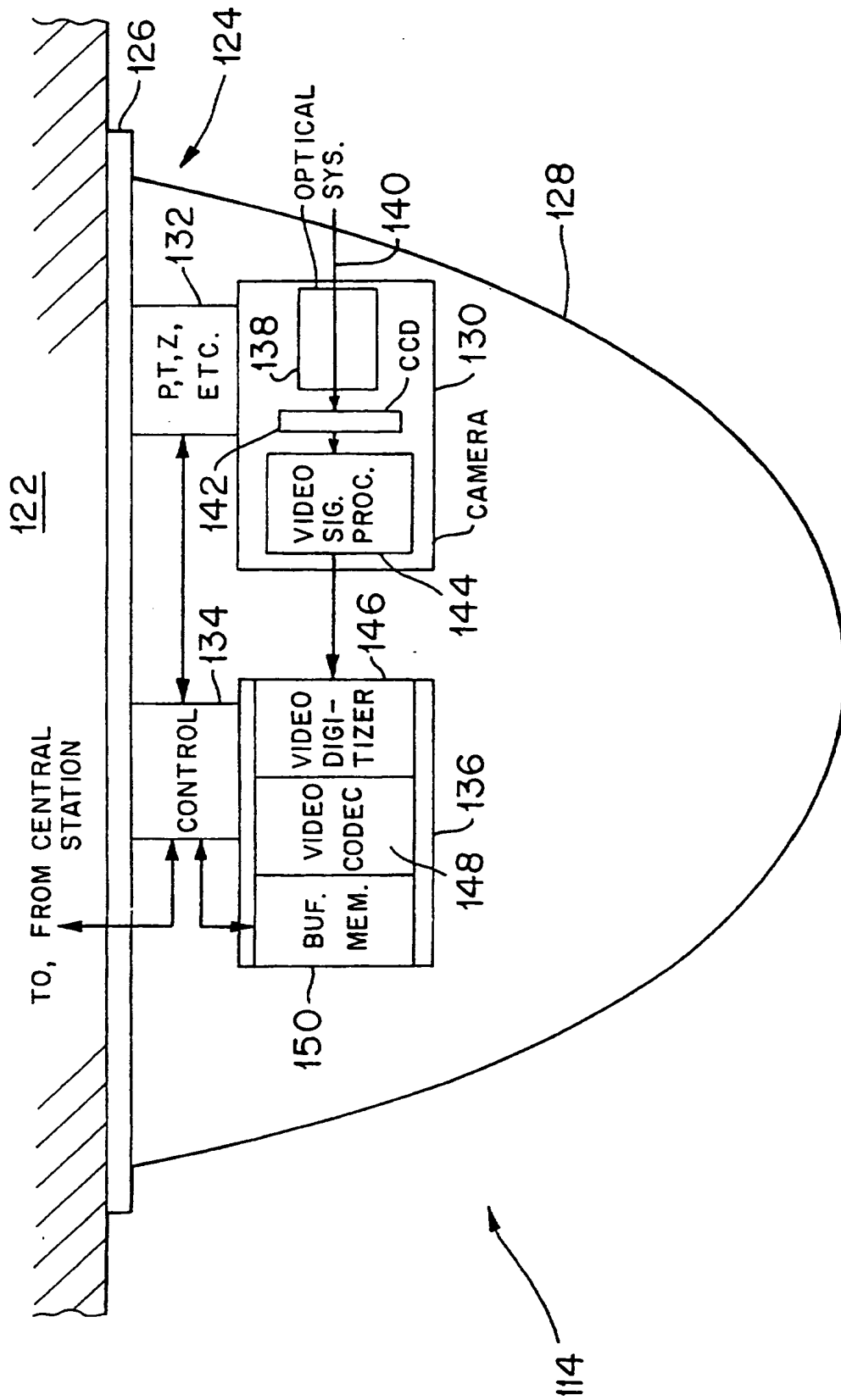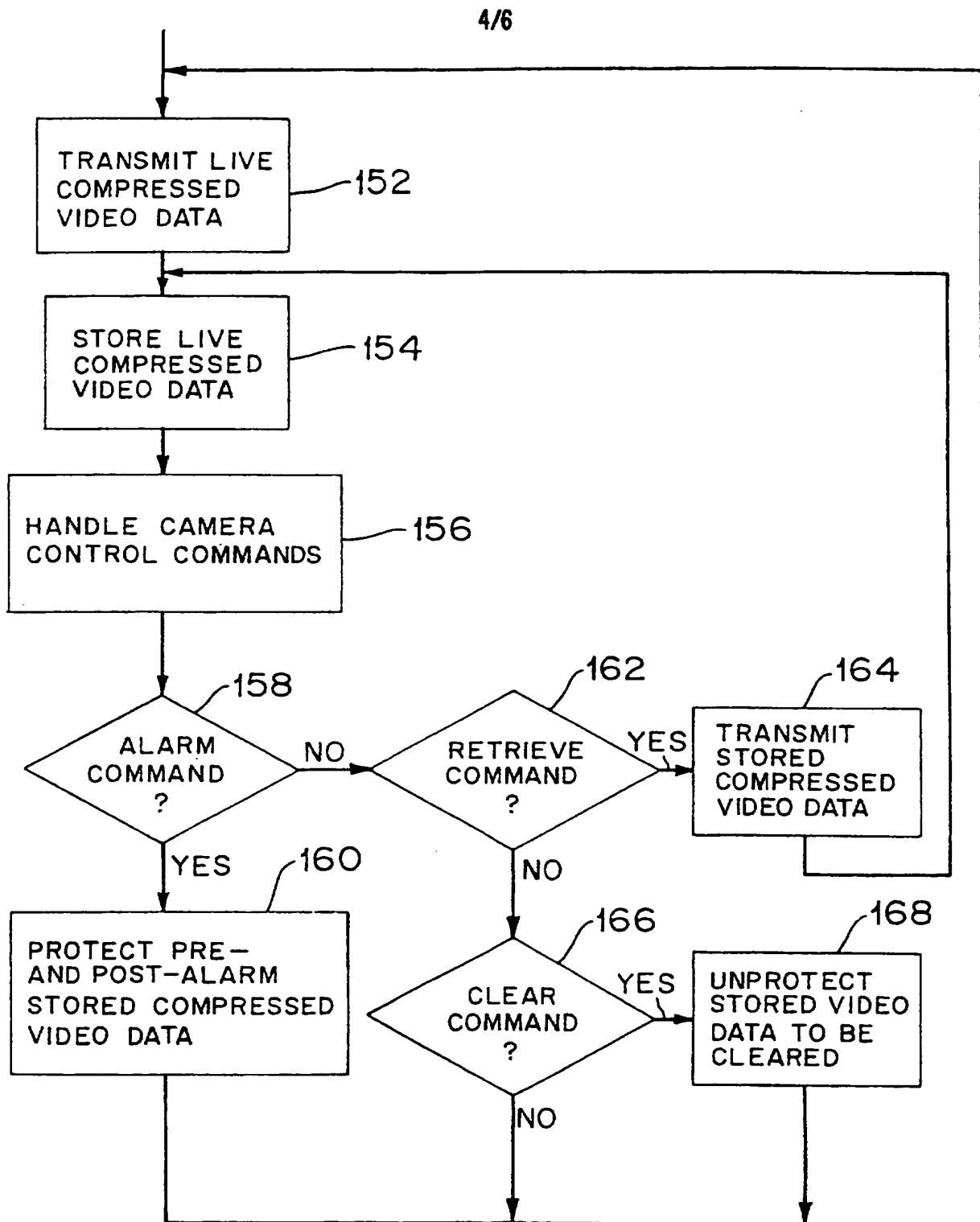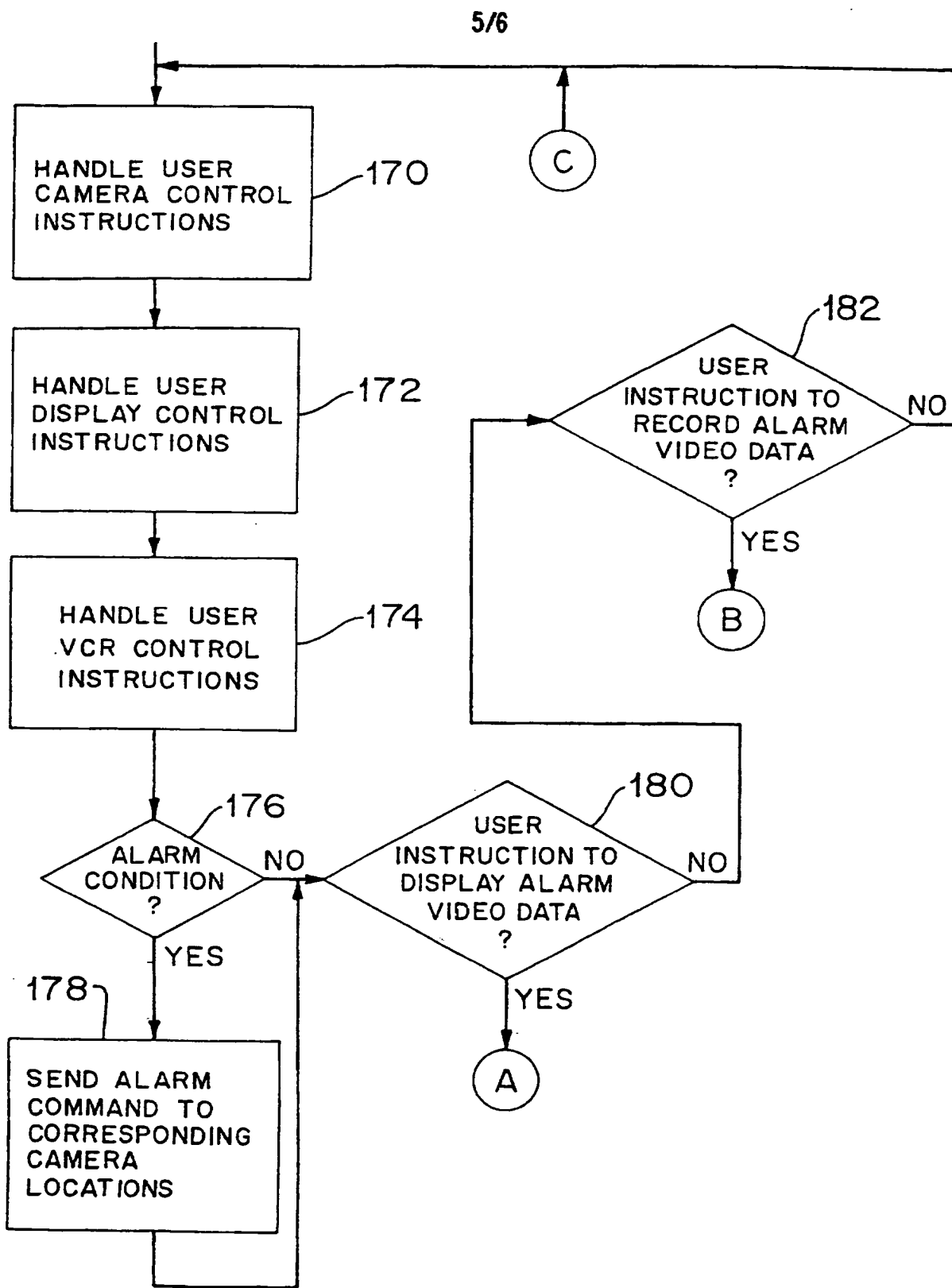*FIG. 2*

FIG. 3

FIG. 4

CAMERA UNIT OPERATION

FIG. 5A
SYSTEM OPERATION

Ⓐ

SEND RETRIEVE
COMMAND TO
SELECTED CAMERA
LOCATION ——184

DISPLAY
RETRIEVED ALARM
VIDEO DATA
ON SELECTED
MONITOR ——186

188

USER
INSTRUCTION
TO RECORD RETRIEVED
ALARM VIDEO
DATA ?   NO

YES ——190

SEND COMMAND
TO CLEAR
RETRIEVED ALARM
VIDEO DATA
FROM CAMERA
BUFFER

OUTPUT RETRIEVED
ALARM VIDEO
DATA TO VCR;
CONTROL VCR
TO RECORD ——192

Ⓑ ——194

SEND RETRIEVE
COMMAND TO
SELECTED CAMERA
LOCATION

SEND COMMAND
TO CLEAR
RETRIEVED ALARM
VIDEO DATA
FROM CAMERA
BUFFER

196

OUTPUT RETRIEVED
ALARM VIDEO
DATA TO VCR;
CONTROL VCR
TO RECORD

198

Ⓒ

FIG. 5B
SYSTEM OPERATION

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 7/18, 9/47
US CL : 348/143, 151, 153, 159

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 348/143, 151, 153, 159, 150

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X __ Y	US 5,229,850 A (TOYOSHIMA) 20 July 1993, fig. 7, elements 2, 11, 13, 3, 13A, 16, 1, 25, 14.	1, 9, 11, 20 and 24-29 _____ 2-8, 10, 12-19 and 21-23
Y	US 4,833,534 A (PAFF ET AL) 23 May 1989, Col. 1, lines 9-20, col. 4, line 4,	2-8, 10, 12-17, 19 and 21-23
Y	US 4,736,218 A (KUTMAN) 05 April 1988, col. 3, lines 55-56, col. 12, lines 26-31.	18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

Date of the actual completion of the international search	Date of mailing of the international search report
04 JULY 1997	0 3 SEP 1997

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	JHON T. DIEP
Facsimile No. (703) 305-3230	Telephone No. (703) 305-4648

Form PCT/ISA/210 (second sheet)(July 1992)*